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Docket No. 53674-015

PATENT

#25 9/26/02 3/13

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of

Hitoshi Sumiya

Serial No. 09/462,876 — Group Art Unit: 1755

Filed: January 18, 2002 — Examiner: K. Group

For: NITRIDE SINTERED COMPACT

TRANSMITTAL OF APPEAL BRIEF

Commissioner for Patents
Washington, DC 20231

Sir:

Submitted herewith in triplicate is Appellant(s) Appeal Brief in support of the Notice of Appeal filed April 24, 2001. Please charge the Appeal Brief fee of $320.00 to Deposit Account 500417.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

MCDERMOTT, WILL & EMERY

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APPEAL BRIEF

Commissioner for Patents
Washington, DC 20231

Sir:

This Appeal Brief is submitted in support of the Notice of Appeal filed July 23, 2002.

I. REAL PARTY IN INTEREST

The real party in interest SUMITOMO ELECTRIC INDUSTRIES, LTD.

II. RELATED APPEALS AND INTERFERENCES

Appellants are unaware of any related appeals or interferences.

III. STATUS OF CLAIMS

Claims 1 and 4 through 10 are pending in this application. The claims have been rejected

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in no less than four Office Actions, the most recent rejection of the appealed claims appearing in the Office Action dated April 30, 2002. It is from the repeated rejections of claims 1 and 4 through 10 that this Appeal is taken.

IV. STATUS OF AMENDMENTS

No Amendment has been submitted subsequent to the issuance of the most recent Office Action dated April 30, 2002.

V. SUMMARY OF THE INVENTION

The present invention addresses and solves problems associated with cubic boron nitride sintered compact tools employed for face milling cutters or end mills for cutting cast irons or steels (page 1 of the written description of the specification, third full paragraph). Particular problems addressed and solved by the claimed invention attendant upon the use of such cubic boron nitride sintered compact tools include breakage due to lowering of the strength of the sintered compact with increasing cutting edge temperatures during cutting, and the occurrence of thermal cracks which lowers the tool life (first full paragraph on page 2 of the written description). The present invention also addresses the difficulty in sharply finishing the cutting edge without chipping, which problem renders it difficult to employ the cutting tool for precision cutting tool operations (first full paragraph on page 4 of the written description of the specification). Appellants have found that cubic boron nitride sintered compacts compressed from ultra-high pressure exhibit anisotropic properties resulting in lamina cracking or stripping (second full paragraph on page 5 of the written description).

Appellants address and solve such problems by subjecting low crystallinity boron nitride

or fine grain, normal pressure type boron nitride free from adsorbed gasses or boron oxide, as a starting material, to direct conversion into cubic boron nitride, followed by sintering at a high pressure and temperature (paragraph bridging pages 10 and 11 of the written description of the specification). The resulting cutting tool has an average grain diameter no greater than one micron, a particular diffraction intensity ratio indicative of an isotropic properties, a minimum transverse rupture strength and a particular thermal conductivity at the edge part, which limitations are recited in independent claim 1.

The significance of such limitations is discussed in the paragraph bridging pages 12 and 13 of the written description of the specification and the first and second full paragraphs on page 13 thereof. Appellants would note that the Examiner has not disputed the significance of such limitations, such as average grain diameter with respect to sharpness and the significance of the x-ray diffraction intensity ratio, i.e., anisotropic properties, to avoid limanar cracking and stripping. The Examiner also does not dispute the disclosed significance of the transverse rupture strength with respect to cutting edge strength and service life, or the disclosed significance of the thermal conductivity with respect to service life. *In re Clinton, 527 F.2d 1226, 188 USPQ 365 (CCPA 1976).*

Significantly, the specification contains data, including comparison data, illustrating that the properties specified in claim 1 don't just happen to occur, but depend on various factors, including the selection of the particular starting material, conversion temperature and sintering temperature (Tables 2 through 6). *In re Glaugh, __F.3d__, 61 USPQ2d 1151 (Fed. Cir. 2002); In re Soni, 54 F.3d 746, 34 USPQ2d 1685 (Fed. Cir. 1995); In re Margolis, 785 F.2d 1029, 228 USPQ 940 (Fed. Cir. 1986).*

VI. ISSUES

A. The Rejections:

1. Claims 1 and 4 through 8 were rejected under 35 U.S.C. §102 for lack of novelty or, alternatively, under 35 U.S.C. §103 for obviousness predicated upon U.S. Patent No. 5,691,260 (Suzuki et al.) and JP 09059068 (JP'068), each taken alone; and

2. Claims 9 and 10 were rejected under 35 U.S.C. §103 for obviousness predicated upon Kawaski in view of Suzuki et al.

B. The Issues Which Arise In This Appeal And Require Resolution By The Honorable Board of Patent Appeals and Interferences (the Board) Are:

1. Whether claims 1 and 4 through 8 are unpatentable under 35 U.S.C. §102 for lack of novelty or, alternatively for obviousness under 35 U.S.C. §103 predicated upon each of Suzuki et al. and JP '068; and

2. Whether claims 9 and 10 are unpatentable under 35 U.S.C. §103 for obviousness predicated upon Kawasaki in view of Suzuki et al.

VII. GROUPING OF CLAIMS

The appealed claims do **not** stand or fall together as a group. Claims 1 and 7 stand or fall together as a group; the patentability of each of claims 4, 5, 6, 8, 9, and 10 is separately advocated.

VIII. THE ARGUMENT

The rejection of claims 1 and 4 through 8 under 35 U.S.C. §102 for lack of novelty or, alternatively, under 35 U.S.C. §103 for obviousness predicated upon Suzuki et al. and JP'068.

Improper Reliance Upon JP'068

The Honorable Board has held that an Examiner's reliance upon an Abstract, without furnishing an English language translation of the underlying document, is improper. *Ex parte Gavin, 62 USPQ2d 1680 (BPAI 2001); Ex parte Jones, 62 USPQ2d 1206 (BPAI 2001).* Thus, as preliminary matter, Appellants would submit that the Examiner's reliance upon JP'068 is improper and, hence, the rejection predicated upon JP'068 should be reversed.

The Examiner's Burden

The Examiner is charged with the initial burden of establishing a prima facie basis to deny patentability to a claimed invention under any statutory provision. *In re Mayne, 104 F.3d 1339, 41 USPQ2d 1451 (Fed. Cir. 1997).* Lack of novelty under 35 U.S.C. §102 requires the identical disclosure in a single reference of each element of a claimed invention such as to establish that the identically claimed invention is in the public domain and that such existence would have been recognized by one having ordinary skill in the art. *Crown Operations Ltd. v. Solutia, Inc., __F.3d__, 62 USPQ2d 1917, 1921; In re Spada, 911 F.2d, 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990); Diversitech Corp. v. Century Steps, Inc., 850 F.2d 675, 678, 7 USPQ2d 1315, 1317 (Fed. Cir. 1988).* Accordingly, in imposing the rejection under 35 U.S.C. §102, the Examiner is required to point to "page and line" wherein a single reference identically

discloses each feature of the claimed invention. *In re Rijckaert, 9 F.3d 1531, 28 USPQ2d 1955 (Fed. Cir. 1993)*; *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co., 730 F.2d 1452, 221 USPQ 481 (Fed. Cir. 1984).*

The Claimed Invention

The invention defined in independent claim 1 is directed to a cutting tool having a cubic boron nitride sintered compact edge part. The cubic boron nitride sintered edge part is defined in terms of, inter alia, a particular diffraction intensity ratio indicative of anisotropy, a particular transverse rupture strength defined by a three point bending measurement and a particular thermal conductivity. The Examiner is unable to identify wherein either of the applied references discloses a cutting tool identically corresponding to that claimed exhibiting the recited diffraction intensity ratio, transverse rupture strength and thermal conductivity, thereby placing the claimed invention into knowing possession of the public.

The Examiner's Position

The Examiner does not assert that either of the applied references to Suzuki et al. or JP '068 discloses a cutting tool corresponding to that claimed, notably exhibiting the recited diffraction intensity ratio, transverse rupture strength and thermal conductivity. The Examiner falls back on the doctrine on inherency. The Examiner's reliance upon the doctrine of inherency is misplaced.

The Examiner has not established a Prima Facie Case of Inherency

As held by the Honorable Board in *Ex parte Schricker, 56 USPQ2d 1723, 1725 (BPAI*

2000):

> However, when an examiner relies on inherency, it is incumbent to point to the "page and line" of the prior art which justifies an inherency theory.

That burden has not been discharged.

The requirements for inherency are twofold. Inherency requires certainty and art-recognition. *Finnegan Corp. v. ITC, 180 F.3d 1354, 51 USPQ2d 1001 (Fed. Cir. 1999); In re Robertson, 169 F.3d 743, 49 USPQ2d 1949 (Fed. Cir. 1999).* This issue was recently addressed by the Court of Appeals for the Federal Circuit in *Crown Operations International Ltd v. Solutia, Inc., supra,* wherein an inherency assertion was raised against a patent claim to a composite solar/safety film for use in a laminated window assembly comprising, inter alia, a solar control film which contributes no more than about 2% visible reflectance based upon the total visible incident radiation, in a laminated window assembly. It was asserted that a prior art reference which disclosed an assembly, "arguable of the same composition and thickness of the films disclosed in the '511 Patent" (62 USPQ2d at 1919) inherently satisfy the requirement for no more than about 2% visible reflectance. This inherency argument was dismissed by the Court of Appeals for the Federal Circuit, the Court holding, at 62 USPQ2d 1922, 1923:

> If the two percent reflectance limitation is inherently disclosed by the Gillery patent, it must be necessarily present and a person of ordinary skill in the art would recognize its presence. *In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999); Continental Can, 948 F.2d at 1268, 20 USPQ2d at 1749.* Inherency "may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient. *Id at 1269, 20 USPQ2d at 1749* (quoting *In re Oelrich, 666 F.2d 578, 58, 212 (USPQ 323, 326 (CCPA 1981).*

Appellants recognize that the Examiner does not have laboratory facilities to conduct testing of prior art cutting tools. On the other hand, the Examiner is charged with a procedural

burden under due process of law to establish a prima facie basis to deny patentability to the claimed invention before the procedural burden shifts to Appellants. *In re Mayne, supra.* In inherency determinations, the Examiner bears the burden of providing a factual basis upon which to invoke the inherency determination in the first place. In other words, there must be a factual basis upon which to predicate the determination that an allegedly inherent feature or features is or are necessarily in the applied prior art and would have been recognized by one having ordinary skill in the art. *Finnegan Corp. v. ITC, supra; In re Robertson, supra; Crown Operations International Ltd v. Solutia Inc., supra.* That initial burden has not been discharged.

Indeed, the Examiner, is unable to unearth any factual basis to support the determination that all sintered cubic boron nitride articles having overlapping compositions and grain sizes **necessarily** exhibit the same diffraction intensity ratio, thermal conductivity **and** transverse rupture strength let alone as specified in claim 1, **regardless of how they may have been fabricated and processed and** that such would have been **recognized** by one having ordinary skill in the art. The Examiner has not done that. The Examiner has not uncovered any technical publication or any technological teaching to justify invoking the inherency theory. Rather, the Examiner has improperly **assumed** that all sintered cubic boron nitride articles having overlapping compositions and grain sizes **necessarily** exhibit the same diffraction intensity ratio, thermal conductivity and transverse rupture strength, including those specified in claim 1, **regardless of how they were fabricated**. But something more than assumptions are required, as apparent from the recent holding by the Court of Appeals for the Federal Circuit in *Crown Operations International Ltd. v. Solutia Inc., supra;* when confronted with compositions having arguably the same composition and film thicknesses.

It should, therefore, be apparent that the Examiner has failed to discharge initial burden of a establishing a prima facie basis to invoke the indoctrine of inherency and, hence, impose a rejection under 35 U.S.C. §102 as well the rejection under 35 U.S.C. §103 which has not been articulated on this record. Exacerbating the Examiner's failure to justify invoking the doctrine of inherency are an abundance of technological facts and hard objective evidence undermining any inherency theory.

Objective Evidence in the Specification Undermining Inherency

As previously submitted, there is an abundance of objective evidence in the specification, notably appearing in Tables 2 through 6, which undermine any notion of inherency by demonstrating that the cutting tool properties of a sintered cubic boron tool depend upon, inter alia, the selection of the starting material, conversion temperature and sintering temperature. *In re Glaugh, supra; In re Soni, supra; In re Margolis, supra.*

Specifically, it should be apparent from the reported cutting tests (Tables 2 through 6) in the written description of the specification, that the breakage resistance of samples (Comparative Example 2) is so low that they could not function as a cutting tool in any of the reported tests, in which the diffraction intensity ratio is at 0.02, i.e., outside of the scope of the present invention, which in itself would appear sufficient to undermine the Examiner's resort to the doctrine of inherency. In the cutting test shown in Table 2, for example, since pBN was employed as a starting material, the orientation of the crystal grains was so strong that liminar cracks or peeling would occur leading to early breakage at the edge. The other data are similar, and in the cutting tests shown in Table 6, particularly, Comparative Example 2 suffered from an instantaneously broken cutting edge which exhibited a number of laminar stripped areas.

For the convenience of the Honorable Board, Appellants submit herewith as Exhibit A a Declaration pursuant to 37 C.F.R. §1.132 which focuses upon the data originally presented in the specification and, hence, should be considered by the Board, if for no other reason than to assist the Honorable Board in interpreting the data in the specification. Based upon the data presented in the specification, as highlighted in the Exhibit A Declaration, the sintered cBN having the grain size and diffraction intensity ratio specified in claim 1 exhibits excellent physical mechanical properties as represented by the thermal conductivity and transverse rupture strength, notably apparent from the data of Examples 1 through 6 and Comparative Example 2 in Tables 1 through 6. This relationship can not be relegated to inherency based on overlapping compositions and overlapping grain sizes. Rather, the grain size and diffraction intensity ratio must be controlled as evidenced by the Examples and Comparative Examples in the specification.

Appellants have difficulty understanding how, when faced with the evidence in the specification, the Examiner can simply say that all sintered cubic nitride articles having overlapping compositions and grain sizes **necessarily** exhibit the recited diffraction intensity ratio, let alone the thermal conductivity and transverse rupture strength regardless of all other factors, let alone as specified in claim 1. *Crown Operations International v. Solutia Inc., supra.* And that such would have been recognized by one having ordinary skill in the art. *Crown Operations International v. Solutia Inc., supra.*

The Rejection Under 35 U.S.C. §103

Appellants submit that the Examiner has not even attempted to state a prima facie basis to deny patentability to the claimed invention under 35 U.S.C. §103. Indeed, the Examiner has not

made any factual determinations as to the scope and content of the prior art, the level of ordinary skill in the art, the differences between the claimed invention and the prior art, or attribute any consideration to the indicum of nonobviousness of record. *Crown Operations International v. Solutia Inc., supra; Graham v. John Deere Co., 86 S.Ct. 684, 383 U.S. 1, 148 USPQ 459 (1966).* Certainly, the Examiner has not made a "thorough and searching" factual inquiry and, based upon such a factual inquiry, explain **why** one having ordinary skill in the art would have been realistically motivated to modify either of the applied references to arrive at the claimed invention. *In re Lee __F.3d__, 61 USPQ2d 1430, 1433 (Fed. Cir. 2002).*

The Dependent Claims

Appellants separately argue the patentability of each of claims 4, 5, 6 and 8. Based upon the arguments submitted supra, it should be apparent that the Examiner has not provided any factual basis upon which to predicate the determination that the cutting tool disclosed by either Suzuki et al. or JP '068 necessarily exhibits the diffraction intensity ratio, transverse rupture strength and thermal conductivity specified in independent claim 1, and that such properties would have been recognized by one having ordinary skill in the art. *Crown Operations International v. Solutia Inc., supra.* More to the point, the Examiner's attempt to invoke the doctrine of inherency is improperly predicated upon assumptions. *Electro Medical Systems S.A. v. Cooper Life Sciences, Inc., 34 F.3d 1048, 32 USPQ2d 1017 (Fed. Cir. 1994); Continental Can Co. USA, Inc. v. Monsanto Co., 948 F.2d 1264, 20 USPQ2d 1746 (Fed. Cir. 1991); In re Oelrich, 666 F.2d 578, 212 USPQ 323 (CCPA 1981).*

Going one step further, the Examiner's reliance upon assumption is stretched beyond its elastic limit when confronted with the additional limitation of claim 4 with respect to hardness,

the additional limitation in claim 5 for thermal conductivity, the additional limitation of claim 6 with respect to thermal expansion coefficient and the additional limitation in claim 8 with respect to grain diameter. In other words, the Examiner's reliance upon assumptions becomes exacerbated with the number of inherency determinations, such as the additional limitations in each of claims 4, 5, 6 and 8, the separate patentability of which is advocated.

The rejection of Claims 9 and 10 under 35 U.S.C. §103 for obviousness predicated upon Kawasaki et al. in view of Suzuki et al.

The Examiner concluded that one having ordinary skill in the art would have been motivated to modify the methodology of Suzuki et al. by employing the hBn particles disclosed by Kawasaki et al. The Examiner's approach falls far short of the "thorough and searching" factual inquiry mandated by the Court of the Appeals for the Federal Circuit. *In re Lee, supra.*

Specifically, as argued throughout prosecution of this application, Kawasaki et al. merely disclose the use of hBN particles in forming sintered bodies. The Examiner would stop the methodology of Kawasaki et al., extract the hBN particles employed by Kawasaki et al. for sintering, and then employ them in the methodology disclosed by Suzuki et al., the only motivation for which is found in Appellants' disclosure--forbidden territory for excavation. *Panduit Corp. v. Dennison Mfg. Co., 810 F.2d 1561, 227 1 USPQ2d 1593 (Fed. Cir. 1987).*

The Examiner ignores the fact that Suzuki et al. employ pBN to obtain a cBN sintered compact which is highly oriented in the (111) structure and, hence, exhibits anisotropic properties in strength and direction, with a very low strength. However, in accordance with the present invention, isotropic properties are optimized, thereby obtaining high strength by developing a fine grain and high purity hexagonal normal pressure type of boron nitride, capable

of increasing the phase conversion efficient from hexagonal to cubic, not the pyrolytic boron nitride.

Appellants would further note that Kawasaki et al. disclose a process for producing a low pressure phase boron nitride from a compound containing boron and oxygen. However, Kawaski et al. seek high crystallinity, as represented by a graphitization index (GI) of 12.5 (column 6 Kawsaki et al., lines 33 through 42). In other words, Kawasaki et al. desire high crystallinity of hBN before ultra-high pressure sintering. Thus, a GI value of 1 to 2.5 is specified.

In contradistinction to the teachings of Kawasaki et al., in accordance with the present invention, the crystallinity of BN, before ultra-high pressure sintering, is worse and in the X-ray diffraction patterns, the (102) diffraction line is hardly observed. Accordingly, when the GI value is calculated, as below, it becomes infinite which clearly underscores the difference between the present invention and Kawasaki et al.

As disclosed by J. Thomas, et al., in the J.An. Chen.Soc 84, 4619 (1962), the GI can be calculated as follows:

$$GI = [\text{area } \{100)+(101)\}] / [\text{area } (102)].$$

In accordance with the present invention, the resulting normal pressure type BN has a low crystallinity (GI is infinite because the area 102) equals zero has can be gathered from the written description of the specification notably commencing at the paragraph bridging pages 10 and 11. Accordingly, the low pressure phase type BN obtained by Kawasaki et al. can not achieve the effects of the present invention.

Suzuki et al. disclose a process for producing cBN by direct conversion; however, Suzuki et al. employ pyrolytic BN as a starting material. Pyrolytic BN is obtained by chemical vapor deposition (CVD) comprising reacting a borane type compound, such as B_2H_6 or BF_2, with a

nitrogen containing gas, such as ammonia, in the gaseous phase. However, in accordance with the claimed invention, a compound containing boron and oxygen are reduced and nitrided in the presence of carbon and nitrogen to synthesize a low pressure phase boron nitride. In other words, the low pressure phase BN is synthesized by solid phase reaction.

Boron nitrides obtained by the claimed method and the methodology of Suzuki et al. are markedly different in properties. Specifically, the pyrolytic boron nitride exhibits high crystallinity, the grain size being in the form of a plate and the orientation tends to be higher during molding. On the other hand, in accordance with the present invention, a boron nitride is obtained having a low crystallinity and isotropic orientation, as characterized by the recited diffraction intensity ratio. Appellants would refer to the discussion in the written description of the specification, commencing at page 5, second full paragraph, wherein Appellants reveal that: "However, these cBn sintered compacts have the problems that compressed hBN crystal grains at an ultra-high pressure tends to remain in the cBN sintered compact and exhibits strong orientation property (anisotropic property) of cBN crystals, resulting laminar cracking or stripping."

The above argued difference is manifested by the recited diffraction intensity ratio as specified in claim 1, which can not be derived from the applied prior art. The inventions of Suzuki et al. and Kawasaki et al. are completely different from the claimed product and its properties and, hence, the claimed method.

In this respect, Appellants would further separately argue the patentability of **claim 10** which requires a particular temperature, a significant feature of the claimed invention which the Examiner has not addressed.

It should, therefore, be apparent that a prima facie basis to deny patentability to the

claimed invention has not been established. Exacerbating the lack of a prima facie case is the abundance of evidence of record demonstrating that the starting material and temperature of conversion and sintering temperatures are variables which impact the properties of the resulting product. The Examiner has improperly ignored such evidence of record. *In re Glaugh, supra; In re Soni, supra; In re Margolis, supra.*

Conclusion

Based upon the arguments submitted supra, Appellants submit that the Examiner has failed to establish a prima facie bases to deny patentability to any of the claims under 35 U.S.C. §102 or 35 U.S.C. §103. Appellants further submit there is an abundance of evidence of record which undermines any attempt to invoke the doctrine of inherency and supports the nonobviousness of the claimed invention as a whole.

Appellants, therefore submit that the Examiner's rejection of claims 1 and 4 through 8 under 35 U.S.C. §102 for lack of novelty or, alternatively, under 35 U.S.C. §103 for obviousness predicated upon each of Suzuki et al. and JP '068, and the Examiner's rejection of claims 9 and 10 under 35 U.S.C. §103 for obviousness predicated upon Kawasaki et al. and Suzuki et al. are not factually or legally viable.

IX. PRAYER FOR RELIEF

Based upon the previously submitted advanced arguments, Appellants submit that each of the Examiner's rejections under 35 U.S.C. §102 and 35 U.S.C. §103 is not factually or legally viable. Appellants, therefore, respectfully solicit the Honorable Board to reverse each of the

Examiner's rejections.

To the extent necessary, a petition for an extension of time under 37 CFR § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

MCDERMOTT, WILL & EMERY

A J Steiner

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Date: September 19, 2002

APPENDIX

1. (Twice Amended) A cutting tool comprising, as an edge part, a cubic boron nitride sintered compact containing cubic boron nitride having an average grain diameter of at most 1 μm, in which the cubic boron nitride sintered compact has, at the said edge part, an $I_{(200)}$, $/I_{(111)}$ of (220) diffraction intensity ($I_{(200)}$ to (111) diffraction intensity $I_{(111)}$ ratio of at least 0.05 in X-ray diffraction of arbitrary direction and impurities are substantially not contained in the grain boundaries, wherein the traverse rupture strength of the said cubic boron nitride sintered compact is at least 80 kgf/mm^2 by a three point bending measurement at a temperature between 20°C and 1000°C and the thermal conductivity of the cubic boron nitride sintered compact, at the said edge part, is 250 to 1000 W/m · K.

4. The cutting tool as claimed in claim 1, wherein the hardness of the cubic boron nitride sintered compact, at the said edge part, is at least 4000 kgf/mm^2 at room temperature.

5. (Amended) The cutting tool as claimed in claim 1, wherein the thermal conductivity of the cubic boron nitride sintered compact, at the said edge part, is 300 to 100 w/m-K.

6. (Amended) The cutting tool as claimed in claim 1, wherein the thermal expansion coefficient of the cubic boron nitride sintered compact, at the said edge part is 3.0 to 4.0 x 10^{-6}/K at a temperature ranging from 20°C to 600°C.

7. (Amended) The cutting tool as claimed in claim 1, which is applied to a face milling cutter or end mill for high speed cutting cast irons or steels.

8. (Amended) The cutting tool as claimed in claim 1, wherein the cubic boron nitride sintered compact, at the said edge part, contains cBN with an average grain diameter of at most 0.5 μm.

9. (Amended) A process for the production of a sintered compact for a cutting tool containing cubic boron nitride with an average grain diameter of at most 1 μm, which comprises reducing and nitriding boron oxide or boric acid in the presence of carbon and nitrogen to synthesize a low pressure phase boron nitride and subjecting the resulting low pressure phase boron nitride, as a starting material, to direct conversion into cubic boron nitride at a high temperature and high pressure, while simultaneously sintering.

10. The process for the production of a sintered compact for a cutting tool, as claimed in claim 9, wherein the said direct conversion and sintering are carried out a pressure of at least 6 GPa and a temperature of 1550 to 2100°C.

EXHIBIT A

IN THE UNITED STATES PATENT OFFICE

In re application of	:
Hitoshi SUMIYA et al.	:
Serial No.: 09/462,876	: Group Art Unit : 1755
Filed January 18, 2000	: Examiner :
A CUTTING TOOL OF A CUBIC BORON	:
NITRIDE SINTERED COMPACT	

DECLARATION UNDER RULE 132

Honorable Commissioner of Patents and Trademarks

Washington, D.C.

Sir:

I, Hitoshi Sumiya, declare that I am a citizen of Japan, residing in c/o Itami Works of Sumitomo Electric Industries, Ltd., 1-1, Koyakita 1-chome, Itami-shi, Hyogo, Japan,

That in 1984, I was graduated from Division of Material Physics, Graduate School of Engineering Science, Osaka University,

That in 1984, I have entered the employ of Sumitomo Electric Industries, Ltd. and posted to a member of Itami R&D Laboratories,

and

That the following experiments were carried out under my immediate supervision and control for the purpose of showing that the boron nitride sintered compact for cutting tools of the present invention has better properties and performances than those of the prior art, for example, high thermal conductivity, low thermal expansion coefficient, high strength and high wear resistance.

Experiments

A milling cutters of the present invention and prior art were prepared and subjected to cutting tests, thus obtaining results illustrated below:

Experiment 1

An exemplified process for the production of a cBN sintered compact composing a cutting edge will be illustrated in the following:

Boron oxide (B_2O_3) and melamine ($C_3N_6H_6$) were combined in a mole proportion of 3 : 1 and uniformly mixed in a mortar. Then, the mixture was treated in nitrogen gas atmosphere in a tubular furnace at a synthesis temperature of 850 ℃ for 2 hours. The resulting powder was washed with ethanol to remove unreacted B_2O_3 and further treated in nitrogen gas in a high frequency furnace at 2100 ℃ for 2 hours. The oxygen content in the resulting boron nitride powder, measured by gas analysis, was 0.75 weight %. This oxygen is regarded as an impurity dissolved in hBN, since B_2O_3 and adsorbed gases were completely removed by the heat treatment in nitrogen gas at 2100 ℃.

In an X-ray diffraction pattern of the resulting boron nitride, there was no (102) diffraction line of hBN and (002) diffraction line of hBN was so broad that its crystallinity was considerably low. Calculation of a crystallite size Lc from the half-band width of hBN (002) diffraction line taught 8 nm. This low crystallinity, normal pressure type BN powder was compressed by 6 tons/cm^2 and molded, and the resulting molding was treated again in nitrogen gas in a high frequency furnace at 2100 ℃ for 2 hours.

The synthesized low crystallinity, normal pressure type BN molding was charged in a Mo capsule and treated at 6.5 GPa and 1800 ℃ for 15 minutes in an ultra-high pressure-producing apparatus of Belt type. Thus, it was found by X-ray diffraction analysis that the resulting sintered compact was composed of only cBN. In the X-ray diffraction of this cBN, the ratio of (220) diffraction intensity of cBN to (111) diffraction intensity of cBN was found to be 0.22, thus teaching that it was an isotropic sintered compact with less orientation. When the microstructure of this cBN sintered compact was observed

by a transmission electron microscope, it was found that the cBN had a fine grain size, i.e. at most 0.3 μm and formed a dense structure of grains bonded with each other.

In addition, when this hardness was measured by a microknoop indenter, it was high hardness, i.e. 5000 kgf/mm^2. When this sintered compact was worked into a rectangular parallelepiped with 6 × 3 × 1 mm, after which the surface was mirroy-wise polished, and subjected to measurement of its transverse rupture strength at a condition of a span interval of 4mm, high transverse rupture strength was given, i.e. 110 kgf/mm^2 at room temperature and 120 kgf/mm^2 at 1000 ℃. The heat resistance was measured by a change of the hardness after a high temperature treatment in vacuum using a vacuum furnace, thus obtaining a result that the compact was stable up to 1300 ℃ and excellent in heat resistance. The thermal conductivity of the sintered compact measured, after working into a rectangular parallelepiped with 5 × 4 × 1 mm, in conventional manner at 50 to 60 ℃ was 290 W/m・K and the thermal expansion coefficient measured in a temperature range of 20 ℃ to 600 ℃ was 3.7×10^{-6}/K.

Experiment 2 (for comparison)

A commercialy available molded article of pBN was used. This was treated in N_2 gas and a high frequency furnace at 2100 ℃ for 2 hours and the oxygen content was determined by gas analysis to give 0.02 weight %. This was treated at 7.5 GPa and 2100 ℃ for 15 minutes in an ultra-high pressure-producing apparatus of Belt type. A tenacious cBN sintered compact was obtained, but this cBN sintered compact hardly showed (220) diffraction line in X-ray diffraction. This sintered compact was found to be a highly anisotropic sintered compact selectively orientated in (111) plane direction having a ratio of cBN (220) diffraction intensity/cBN (111) diffraction intensity of at most 0.02.

In addition, in the X-ray diffraction, there was found compressed hBN near an interplanar spacing d = 3.1Å. When the microstructure of this cBN sintered compact was observed by a transmission electron microscope, it was found that

the cBN was so fine as represented by a grain size of at most 0.5 μm and formed a dense structure of grains bonded with each other. In addition, when this hardness was measured by a microknoop indenter, it was high hardness, i.e. 4800 kgf/mm^2. The transverse rupture strength of this sintered compact was low, i.e. 82 kgf/mm^2 at room temperature. The thermal conductivity measured at 50 to 60 ℃ was 320 W/m・K, while the thermal expansion coefficient measured in a temperature range of 20 ℃ to 600 ℃ was 3.6×10^{-6}/K.

The data obtained in the above Experiments 1 and 2 are tabulated below (Table A):

Table A

Sample No.	Sintering Temp. (℃)	Crystal Grain Diameter (μm)	cBN X-ray Diffraction Strength Ratio $I_{(220)}/I_{(111)}$	Thermal Conductivity (W/m・K)	Thermoal Expansion Coefficient ($x\ 10^{-6}$/K)	Transverse Rupture Strength (Room temp.) (kgf/mm^2)	Hardness (kgf/mm^2)
Experiment							
1	1800	≦ 0.3	0.22	290	3.7	110	5000
2	1880	≦ 0.5	≦ 0.02	320	3.6	82	4800

Samples of Experiments 1 and 2 of the cBN sintered compacts shown in Table A were used as starting materials and a throwaway insert was prepared by brazing each of the above described cBN sintered compacts to a cutting edge holder consisting of a cemented carbide and mounted on a cutter body. As a workpiece to be cut, a plate material of gray cast iron, FC 250, having a cutting surface of 150 x 25 mm was prepared and then subjected to a cutting property test using a unit cutting surface in the 150 mm direction of the plate material as one pass under cutting conditions of a cutting speed of 1500 m/min,

cutting depth of 0.5 mm and feed of 0.15 mm/tooth by wet process. The results are shown in Table B. The number of passes capable of cutting was determined by the time when the flank wear width of the cutting edge reached 0.2 mm or cutting was impossible by breakage.

Table B

Sample No.	Cutting Atmosphere	Workpiece	Number of Passes Capable of Cutting
Experiment 1	wet process	cast iron	300
Experiment 2	-do-	-do-	2

From Experiment 2, it can be considered that since pBN was used as a starting material, the orientation of the crystal grains was so strong that laminar cracks or peelings were liable to occur, leading to early breakage of the edge.

Assessment of the Experiments 1 and 2

From the above Experiments 1 and 2 and the data of Tables A and B, it can be concluded that:

(1) The cBN X-ray diffraction strength ratio $I_{(220)}/I_{(111)}$ can be contolloed by the prepation method of the sample and

(2) the data of $I_{(220)}/I_{(111)}$ is strongly related with the mechanical properties such as transverse rupture strength and hardness of the cBN sintered compact.

Therefore, it is believed that the so-called doctrine of inherency cannot be applied to the present case.

Conclusion

It is apparently concluded from the above described data that the specified constituent features as claimed in the amended claim are critical and when these features are within the scope of the present invention, the surprising and unexpected advantages over the prior art can first be attained.

I declare further that all statements made on information and belief are believed to be true, and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, uner Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed this 10th day of July, 2002

Hitoshi Sumiya

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